NOAA Technical Memorandum NWS SR-196

SEVERE WEATHER CLIMATOLOGY (1950-1995) FOR THE NWSO LAKE CHARLES PARISH/COUNTY WARNING AREA

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March 1998

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1. INTRODUCTION

The National Weather Service (NWS) is nearing completion of its Modernization and Associated Restructuring (MAR). Once this process is complete, the Lake Charles NEXRAD Weather Service Office (NWSO) will assume forecast and warning responsibility for sixteen Louisiana parishes, six Texas counties, and the adjacent coastal waters (Figure1). This paper will serve to address this new responsibility by enhancing the forecaster's knowledge of the local severe weather climatology in the Lake Charles County Warning Area (CWA). The basic assumption is that increased knowledge will lead to more accurate forecasts and warnings.

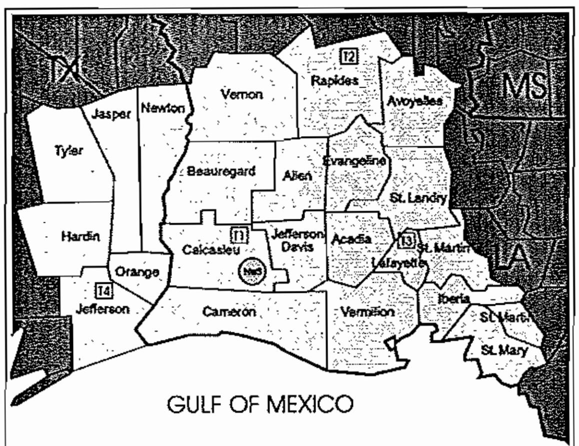

Figure 1. Lake Charles County Warning Area (CWA).

The National Weather Service defines a severe local storm as meeting any one of the following criteria: tornado, hail equal to or greater than 3/4 inch in diameter, convective wind gust greater than or equal to 50 knots, or significant convective wind damage. This study will take each criteria on an individual basis and address the severe weather climatology trends in hourly, monthly, and annual distributions.

2. DATA

The NWS Storm Prediction Center (SPC) maintains an extensive database of severe weather records dating back to 1955 for damaging wind and hail data and back to 1950 for tornado data. From this database, the CLIMO program (Vescio, 1995) was modified to include only parishes and counties in the Lake Charles CWA. The authors of the paper did an objective analysis of the data to generate severe weather statistics and quantify the results. Damaging wind and hail data from 1972 were not included in the SPC database and were therefore supplemented by Storm Data records (NOAA, 1972).

There are however limitations to the data as described by Ostby (1993). These include population biases, increases in population densities, increased emphasis on storm spotting and chasing, and non-uniform event gathering procedures. Hales (1993) further noted that there has been a significant growth in the severe storm database since the National Weather Service began verifying severe storm events in 1980. To account for these non-meteorological influences, data were examined on the hourly and monthly spectrum. Since all the data were subject to the same biases, it would seem one could safely derive trends in severe weather climatology.

3. HAIL CLIMATOLOGY

a) Yearly Distribution

There were 404 hail reports in the Lake Charles CWA between 1955-1995. Overall, hail reports began to trend upward in the late 1970's (Figure 2), with a decrease in the mid and late 1980's, and then a substantial increase in the 1990's. In fact, 70 percent of the documented hail reports have occurred since 1980. As stated earlier, the NWS began formally verifying severe thunderstorm and tornado warnings in 1980; thus, this increase appears to be non-meteorological in nature. In the spring of 1995, several troughs and cut-off lows over the Mississippi River Valley and Gulf Coast brought an unprecedented amount of severe weather reports. That year there were 76 hail reports, more than doubling the second highest year on record, 1991. The decrease in the mid 1980's is more likely a result of meteorological factors than in a disruption of event gathering techniques. Prior to the mid 1970's, reports were nearly uniform as the seek-and-search method for storm reports was not a priority.

b) Monthly Distribution

By examining Figure 3, we find that severe hail events across the Lake Charles CWA can occur during any month.

To further support the seasonal distribution of hail reports, the study divided the reports into three groups based on the size of the hail reported:

Large Hail:	0.75-1.74" in diameter
Giant Hail:	1.75-2.74" in diameter
Enormous Hail:	2.75" or > in diameter

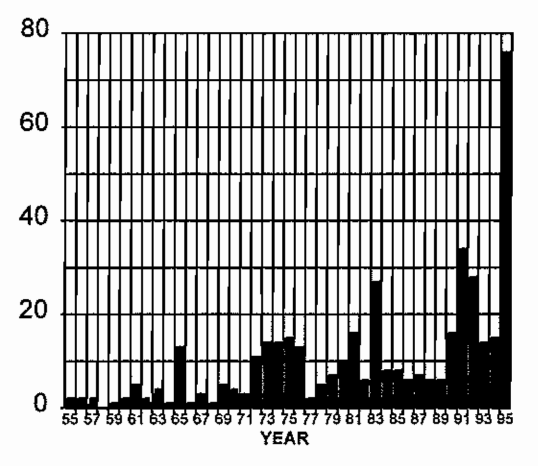

Figure 2. Hail reports by year (1955-1995).

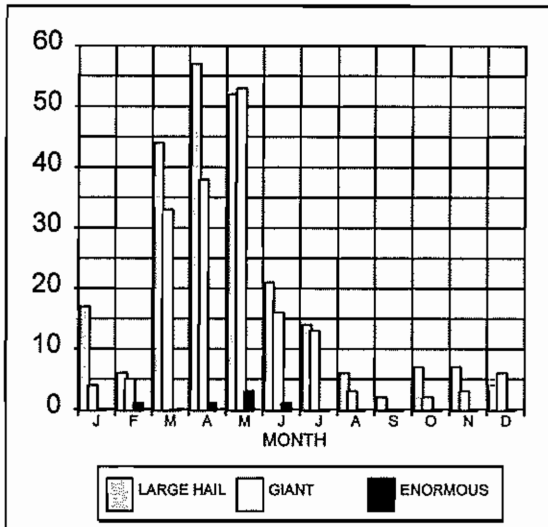

Figure 3. Hail reports by month (1955-1995).

However, the March-May period exhibits the peak months of severe hail. During the springtime peak, optimal freezing and wet-bulb zero levels are attained. Additionally during this time, the transient influence of the westerlies brings fronts through the region. Sufficient moisture off the Gulf of Mexico and warming of the low levels of the atmosphere result in larger CAPE values; thus, the needed instability and stronger updrafts required for hail development are present. In fact, 67 percent of hail reports occur during March-May time period. May is the peak month with 105 reports correlating to 26 percent of all reports.

The decreasing trend in hail reports for the June-September period can be best explained by the higher freezing and wet bulb zero levels and northernmost extent of the westerlies. During this time, fronts reaching the Gulf Coast are a rarity and cold pockets in the mid levels reside over the northern half of the country. A bit of a re-emergence or a secondary peak occurs in the autumn months. The southward migration of the westerlies brings a few strong fronts into the region at this time. Furthermore, there is a lag effect as the low levels remain warm and moist due to the proximity of the Gulf of Mexico.

According to Hales (1993), the actual severe thunderstorm climatology can be best determined by only considering the most significant events. This eliminates the biases associated with collection techniques used to verify severe weather events. Using this technique, Figure 3 continues to show that the peak months of severe hail are March-May. In fact, 71 percent of the giant hail reports and 66 percent of the enormous hail reports occur during this period. In addition, almost half the reports, 45 percent, are either giant or enormous hail.

c) Hourly Distribution

From Figure 4, we can see that hail occurrences are diurnal with the peak occurring from 2 p.m. to 8 p.m. Local Standard Time (LST). The relatively high number of reports in the late evening and early morning between 10 p.m. and 4 a.m. can be best described by Fike (1993) as nocturnal severe local storm outbreaks (NSSO). This phenomenon is most prevalent along the Gulf Coast during the winter and spring months when the westerlies transport large-scale weather systems through the region at all times of the day.

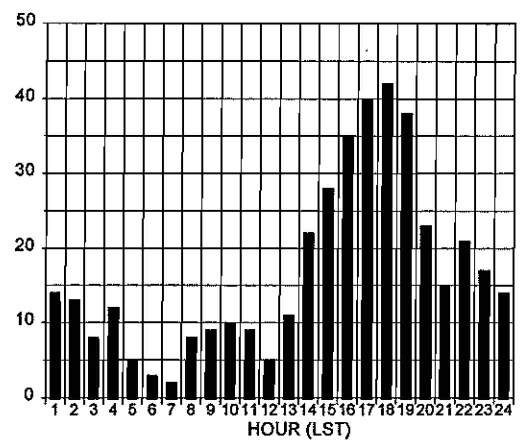

Figure 4. Hail reports by hour (1955-1995).

By examining Figures 5 and 6, we see that October-February and March-May tend to be influenced by either diurnal heating or large-scale weather systems. However, June-September (Figure 7) occurrences are predominantly in the late afternoon and early evening hours with very few events during the morning hours. The warm season (June-September) events are mainly driven by low-level instability which is greatest during the hours of maximum heating.

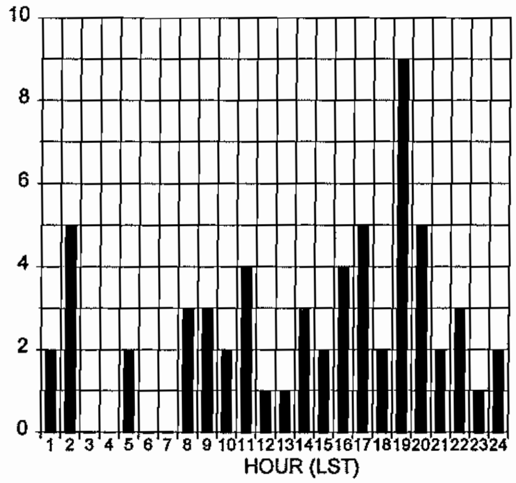

Figure 5. October-February hail reports by hour (1955-1995).

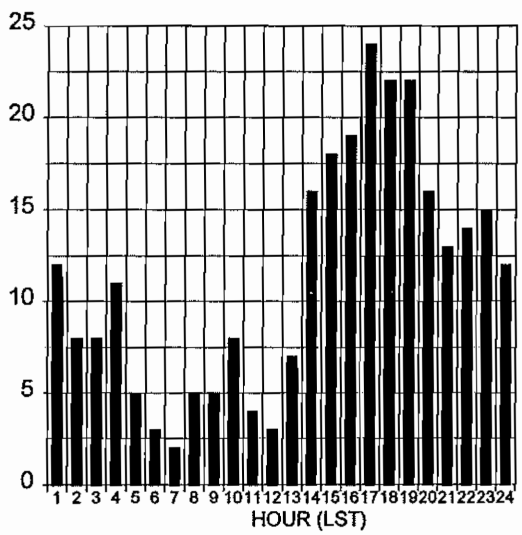

Figure 6. March-June hail reports by hour (1955-1995).

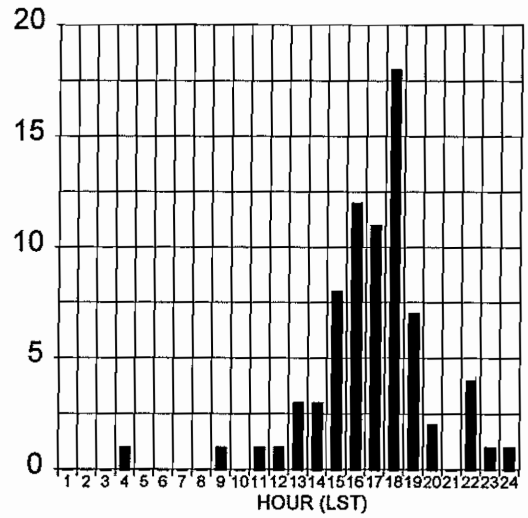

Figure 7. June-September hail reports by hour (1955-1995).

4. WIND CLIMATOLOGY

a) Yearly Distribution

Wind events account for nearly half of the severe weather reports in the Lake Charles CWA. From 1955-1995 there were a total of 1151 events (Figure 8).

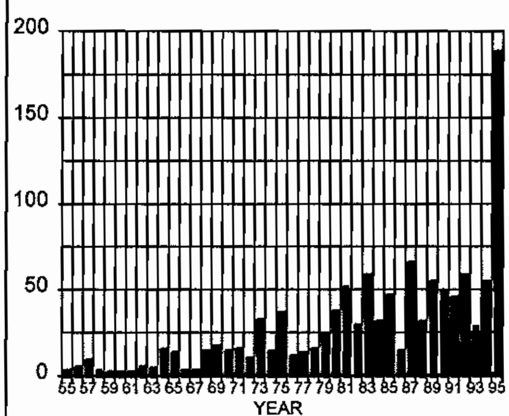

Figure 8. Wind reports by year (1955-1995).

The temporal trends are similar to the hail events in that we see an upward trend beginning in the late 1970's. Once again, non-meteorological factors such as population density and verification techniques appear to be skewing the database. The similarity in data suggests that both wind and hail events appear together. Specifically, the Gulf Coast region experiences most of its severe weather from pulse-type storms. These storms develop in a highly unstable, but weakly sheared environment. The severe pulse storm has a more intense updraft which often favors hail development when compared to the weaker updrafts of ordinary thunderstorms. However, the updraft is short-lived, giving way to an intense downdraft and subsequent period of damaging winds at the surface.

b) Monthly Distribution

Damaging winds can occur during any month as shown in Figure 9, but the March-May period is once again the seasonal peak.

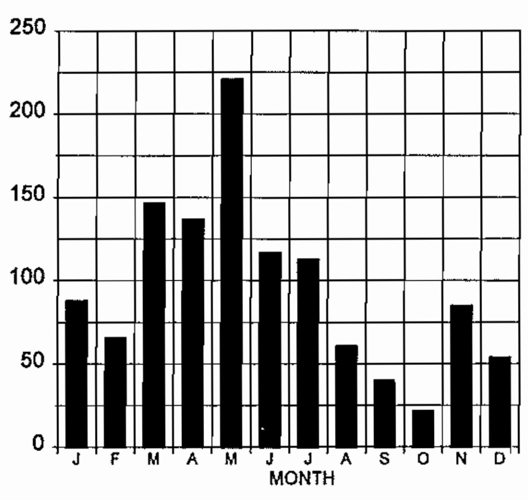

Figure 9. Wind reports by month (1955-1995).

In fact, 44 percent of the damaging wind reports occur during the springtime peak. May is the peak month with 221 reports correlating to 19 percent of all reports. However, unlike hail, wind events do not drop off as sharply after May. Wind events are more evenly distributed through the warm season months than hail events. This is a result of the previously discussed pulse-type thunderstorms.

Although pulse-type thunderstorms produce hail, in the warm season much of the hail melts due to higher freezing levels. Additionally, the environment is weakly sheared during this time inhibiting significant tornado development. However, pulse-type thunderstorms driven by highly unstable environments continue to produce damaging winds. By extending the seasonal peak (March-May) through July, this period now accounts for 63 percent of the wind events.

A secondary peak is also noted in November and is consistent with results found by Kelly et al. (1985). This peak will also be seen in the tornado climatology section. The influence of the westerlies becomes more pronounced at this time of year allowing for frontal systems to push to the Gulf Coast region and collide with warm, unstable air still in place.

c) Hourly Distribution

From Figure 10, we can see that wind events are diurnal with the peak occurring from 2 p.m. to 7 p.m. LST. Another significant feature is the two secondary peaks noted during the morning hours. These can be seen from midnight to 5 a.m. LST and 9 a.m. to noon LST. The first secondary peak may be best explained by the previously discussed NSSO (Fike, 1993), while the second peak also appears to be driven by large-scale weather systems in the cool season (October-May).

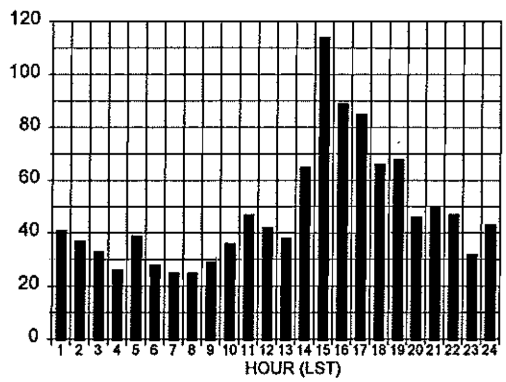

Figure 10. Wind reports by hour (1955-1995).

Again, damaging wind data are similar to hail data with the June-September months being strongly dependent on diurnal heating, while the October-February and March-May events are a combination of large-scale weather systems and diurnal effects (Figures 11, 12, and 13). This results in a more equitable distribution of wind events during the cool season months.

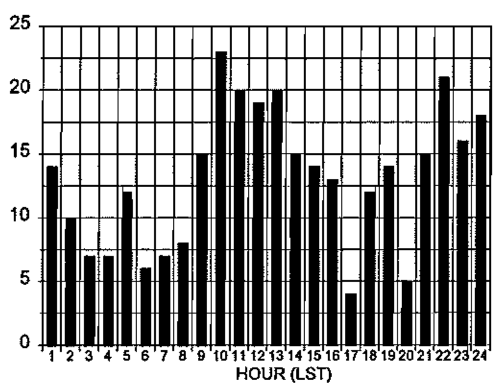

Figure 11. October-February wind reports by hour (1995-1995).

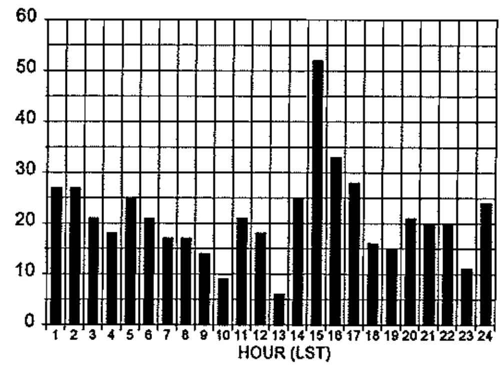

Figure 12. March-May wind reports by hour (1955-1995).

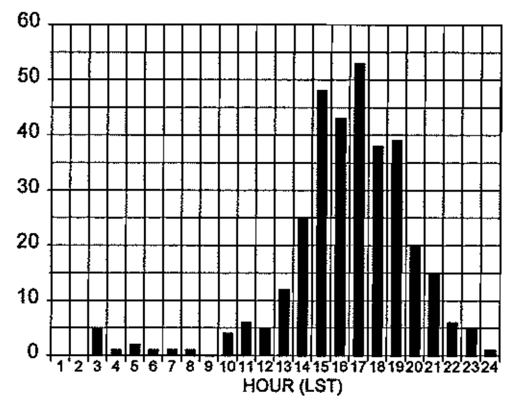

Figure 13. June-September wind reports by hour (1955-1995).

For October-February, the primary peak is between 9 a.m. and 4 p.m. LST with a secondary peak from 9 p.m. to 2 a.m. LST; for March-May, the primary peak is between 2 p.m. and 5 p.m. LST with a secondary from midnight to 5 a.m. LST. Thus, a conclusion can be drawn that wind events can occur almost any time of the day during the cool season months, with the primary peak during the afternoon hours.

5. TORNADO CLIMATOLOGY

a) Tornado Frequency

There were 576 tornadoes reported in the Lake Charles CWA (Figure 14), the annual average is 13, between 1950-1995. Every county/parish in the CWA reported at least one tornado during this period.

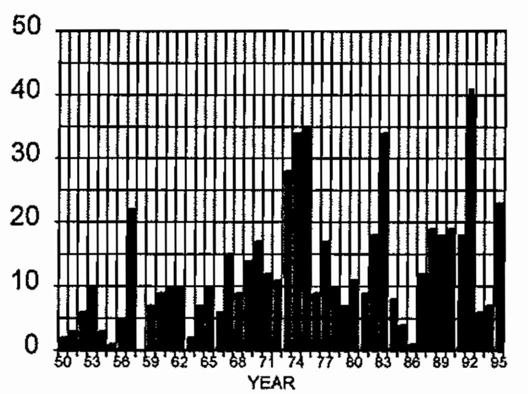

Figure 14. Tornado reports by year (1950-1995).

The upward trend of reports after 1980 in hail and damaging wind occurrences is not as clearly recognizable in the tornado trends (Figure 14). A possible explanation is that some damaging events such as microbursts were classified as tornadoes before 1980 (Grazulis, 1993). Reported U.S. tornadoes which showed a steady increase for several years after the establishment of the National Severe Storm Forecast Center (NSSFC) in the early 1950's, leveled off in the 1970's. Since then, the annual tornado fluctuation seems to be increasingly a function of the shifting weather patterns rather than the reporting system (Hales, 1993).

b) Monthly Distribution

Total tornado reports by month (Figure 15) show a primary peak from March-June and a secondary peak from September-November. The primary peak March-June comprises 44 percent of the events. May is the peak month with 90 reports correlating to 16 percent of all reports. The secondary peak month is November with 60 reports accounting for 11 percent of all reports. The least active months are February and August, with only 5 percent of the annual total in each month.

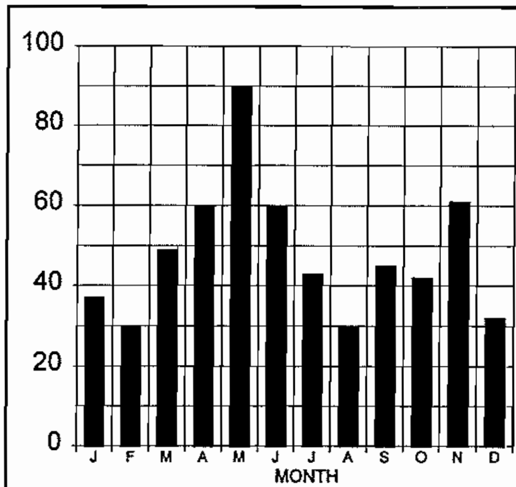

Figure 15. Tornado reports by month (1950-1995).

Similar to the wind events, the distribution of tornadoes does not drop off after May like the hail events. This can be best explained by the development of weak F0 and F1 tornadoes during the summer months. These type of tornadoes form during the rapid development of the updraft in highly unstable environments, often along a pre-existing boundary. This is in contrast to springtime tornadic activity, when strong wind shear and instability are both present.

Some of the deadliest and most damaging tornadoes have occurred during November and December. In fact, around 65 percent of all fatalities and injuries have occurred during the secondary peak. The data point toward more violent tornadoes occurring in the fall or early winter. However, most fatalities and injuries in the secondary peak occurred during a few events which have greatly skewed the data. For example, a strong cold front moved through the Lake Charles CWA on November 7, 1957 spawning numerous tornadoes resulting in 180 injuries and 12 fatalities. Total injuries and fatalities in November from 1950-1995 are 209 and 13, respectively. Appendix I details tornado occurrences, injuries, and fatalities in each parish/county in the Lake Charles CWA.

c) Hourly Distribution

Tornadoes across the Lake Charles CWA have occurred at all times of the day and night (Figure 16), but strike most often between noon and 7 p.m. LST.

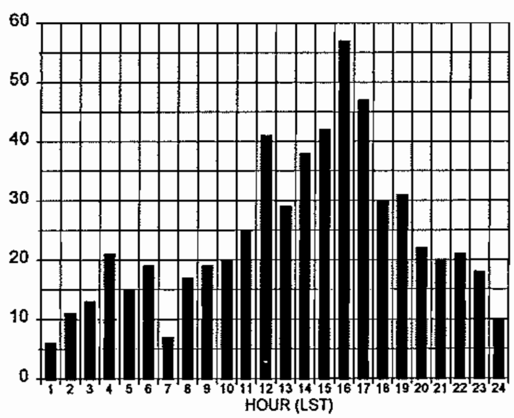

Figure 16. Tornado reports by hour (1950-1995).

Hourly tornado reports during March-May again show that tornadoes occur at all hours peaking in the afternoon and early evening hours (Figure 17).

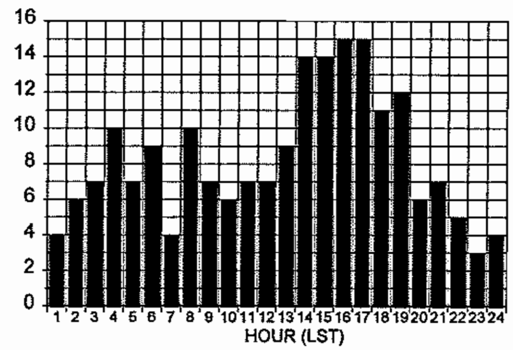

Figure 17. March-May tornado reports by hour (1950-1995).

Like damaging wind events, there is nearly an identical secondary peak in the early morning hours from 2 a.m. to 5 a.m. LST. This again appears to be related to the NSSO which shifts from the Central Plains and the middle Mississippi River Valley during the warm season to the south-central and southeastern U.S. during the winter and spring months. (Fike, 1993). This nocturnal phenomenon is not evident in the June-September period (Figure 18) but is somewhat apparent in the October-February period (Figure 19).

During June-September, tornado events are strictly diurnal with development beginning shortly after sunrise. As mentioned, earlier, these are generally F0 and F1 tornadoes and occur early in the thunderstorm life cycle. During October-February , the activity mirrors the March-May period with an earlier peak in afternoon activity. Clearly, tornadoes in the summer months are associated with maximum diurnal heating while the remainder of the year seems to be a combination of large-scale weather systems and diurnal heating.

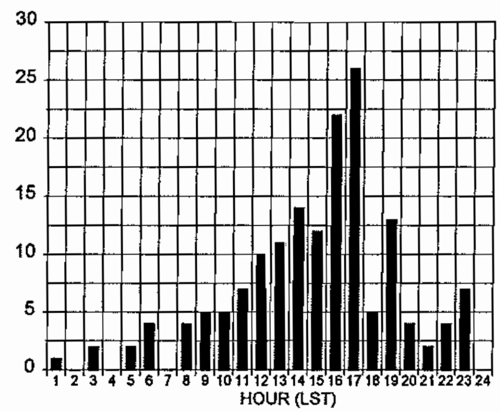

Figure 18. June-September tornado reports by hour (1950-1995).

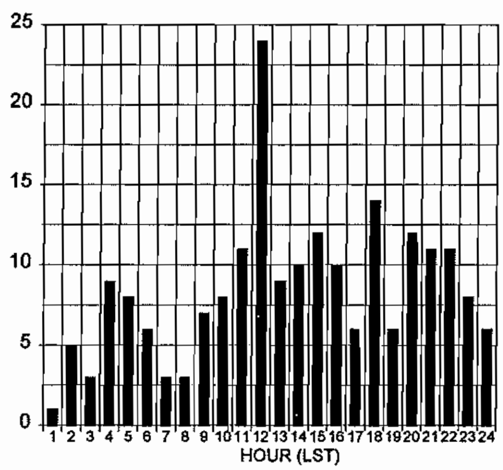

Figure 19. October-February tornado reports by hour (1950-1995).

d) Intensity

Table 1 describes the Fujita Scale which categorizes tornadoes based on the strength of their winds and the damage produced. The categories range from an F0 to F5 in increasing order of an intensity. Most tornadoes in the Lake Charles CWA fall under the lower spectrum of the scale (Figure 20).

The Fujita Scale

Scale Number	Wind (mph)	Damage
F0	40-73	Light
F1	74-112	Moderate
F2	113-157	Considerable
F3	158-206	Severe
F4	207-260	Devastating
F5	>260	Incredible

Table 1.

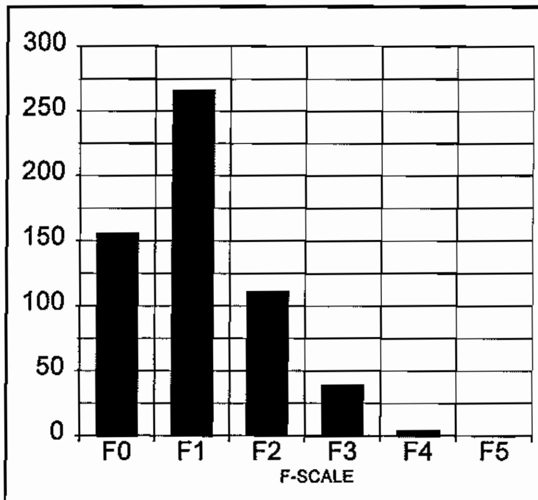

Figure 20. F-Scale frequency (1950-1995).

73 percent have been either an F0 to F1 rating, 19 percent have been classified as an F2, 7 percent as an F3, and less than 1 percent have been classified as an F4. The Lake Charles CWA has never reported an F5 tornado.

6. CONCLUSIONS

Temporal trends of severe weather found in the study reveal a "true" severe weather season for the Lake Charles CWA. Even though severe weather may occur in any month, the highest frequency is during the springtime, specifically from March through May. A second severe weather season was also noted in November. In addition, the study found several secondary diurnal peaks clearly indicating the presence of nocturnal severe weather outbreaks during the cool season.

While hail and damaging wind events are similar in occurrence diurnally, wind events are distinctively different during the warm season months. This is due to weaker synoptic scale forcing and strong low-level instability characterized by the pulse-type storm environment. These storms continue to produce damaging winds in the warm season, but due to the higher freezing levels much of the hail melts before reaching the surface.

Tornado occurrences also do not drop off as sharply after May as hail events. Weak F0 and F1 ratings comprise most of the tornado reports with more significant ratings of F2 or higher occurring during the springtime and autumn months. While the data point toward more destructive tornadoes in the autumn, this is greatly skewed by a few occurrences. Deadly, destructive tornadoes are just as likely in the springtime.

Through examining and understanding severe weather climatology across the Lake Charles CWA, the authors hope that this will lead to improved forecasts and warnings. Emergency managers, utility companies, and severe weather spotters could also benefit from this study.

7. ACKNOWLEDGMENTS

The authors would like to thank Michael Vescio at SPC for providing the SVRPLOT and CLIMO programs; Steve Rinard (MIC), and Felix Navejar (SOO) for suggestions, comments, proofreading, and especially time spent in helping prepare this paper.

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County/Parish	Total Tornadoes 1950-1995	Total Tornado Injuries	Total Tornado Fatalities
Acadia	40	63	5
Allen	7	4	0
Avoyelles	21	19	1
Beauregard	20	19	0
Calcasieu	64	23	0
Cameron	38	44	3
Evangeline	15	3	0
Hardin	14	1	0
Iberia	18	9	0
Jasper	14	1	1
Jefferson	92	123	4
Jefferson Davis	27	28	0
Lafayette	25	46	2
Newton	4	0	0
Orange	24	81	1
Rapides	33	54	4
St. Landry	28	70	6
St. Martin	13	23	1
St. Mary	14	25	0
Tyler	6	4	0
Vermilion	36	73	3
Vernon	23	42	9

Appendix I.

Added page for "Severe Weather Climatology (1950-1995) for the NWSO Lakes Charles Parish/County Warning Area," by R.A. Perkins and D.S. Wally.